CLAIMS

1. A method of separating a plurality of source signals from a composite signal (104) expressed as a series of values of signal amplitude, each source signal having a respective period similar or equal to p, characterised in that the method incorporates the steps of:
   (a) expressing the composite signal (104) as a matrix $\boldsymbol{X}$ having rows each of which is a respective segment of signal amplitude values and corresponds to a length of time associated with a signal cyclet;
   (b) implementing a decomposition of the matrix $\boldsymbol{X}$ by decorrelation and normalisation to obtain decomposition results; and
   (c) performing independent component analysis (ICA) of the decomposition results to obtain at least one of estimated separated signal modulation envelopes and estimated separated signal cyclets.

2. A method according to Claim 1 characterised in that it includes estimating source signal period p by synchronous averaging of the composite signal (104).

3. A method according to Claim 1 characterised in that the decomposition is a singular value decomposition generating decomposition results comprising two singular vector matrices and a singular value matrix, and the step of performing ICA is carried out using one of the singular vector matrices to obtain at least one of an independent component matrix and an associated component matrix one of which matrices contains estimated separated signal modulation envelopes and the other contains estimated separated cyclets.

4. A method according to Claim 3 characterised in that it includes determination of source signal period by trialling a number of possible periods p', steps (a) and (b) are carried out for each possible period p' to derive and decompose a respective matrix $\boldsymbol{X}_{test}$, each matrix $\boldsymbol{X}_{test}$ has a probability associated with its decomposition results, and step (c) is carried out with decomposition results of that matrix $\boldsymbol{X}_{test}$ having maximum probability and taken to be the matrix $\boldsymbol{X}$ associated with the period p subject to this period not corresponding to a multiple of a true period.

5. A method according to Claim 3 characterised in that the signal modulation envelopes are more statistically independent than the cyclets and step (c) is performed on a

singular vector matrix $\boldsymbol{U}$ to obtain an independent component matrix $\boldsymbol{UR_2^T}$ containing estimated separated signal envelopes and a matrix $\boldsymbol{R_2\lambda V}$ containing estimated separated cyclets.

6. A method according to Claim 3 characterised in that the cyclets are more statistically independent than the signal envelopes and step (c) is performed on a singular vector matrix $\boldsymbol{V}$ to obtain an independent component matrix $\boldsymbol{R_1^TV}$ containing estimated separated cyclets and a matrix $\boldsymbol{U\lambda R_1}$ containing estimated separated signal envelopes.

7. A method according to Claim 1 characterised in that it includes an additional step of estimating a number q of source signals with periodicities similar or equal to p present within the composite signal (104) and reducing the decomposition results in accordance with such number prior to performing step (c).

8. A method according to Claim 7 characterised in that the number q of source signals is estimated from the source signals' origins.

9. A method according to Claim 7 characterised in that the number q of source signals is estimated from a number of elements of a singular value matrix λ, the elements having values exceeding a threshold value.

10. A method according to Claim 1 characterised in that the composite signal (104) is detected by a single sensor (12).

11. A method according to Claim 1 characterised in that the source signals are detected by a plurality of sensors (174, 176) each of which provides a respective composite signal (104) from which a respective matrix $\boldsymbol{X}$ is obtained and analysed in steps (a) to (c).

12. A method according to Claim 1 characterised in that the source signals are detected by a plurality of sensors (174, 176) providing respective composite signals, and the matrix $\boldsymbol{X}$ is obtained from the composite signals collectively.

13. A method according to Claim 1 characterised in that it is a method of apparatus condition monitoring, the source signals are obtained with the aid of at least one sensor (12) from a plurality of apparatus sources, and the at least one of estimated separated signal modulation envelopes and estimated separated signal cyclets is analysed for

indications as to the condition of respective apparatus sources.

14. Computer apparatus (150) for separating a plurality of source signals from a composite signal (104) expressed as a series of values of signal amplitude, the source signals having periodicities similar or equal to p, characterised in that the computer apparatus is programmed to:
    (a) express the composite signal (104) as a matrix $\boldsymbol{X}$ having rows each of which is a respective segment of signal amplitude values and corresponding to a length of time associated with a signal cyclet;
    (b) decompose the matrix $\boldsymbol{X}$ by decorrelation and normalisation to obtain decomposition results; and
    (c) perform independent component analysis (ICA) of the decomposition results to obtain at least one of estimated separated signal modulation envelopes and estimated separated signal cyclets.

15. Computer apparatus (150) arranged to separate a plurality of source signals from a composite signal expressed as a series of values of signal amplitude, the source signals having periodicities similar or equal to p, characterised in that the computer apparatus (150) is programmed to:
    (a) partition the composite signal into a plurality of partition matrices $\boldsymbol{X}$ having rows each of which is a respective segment of signal amplitude values and corresponds to a length of time associated with a signal cyclet;
    (b) perform a singular value decomposition (SVD) of at least one of the matrices $\boldsymbol{X}$ to obtain two singular vector matrices $\boldsymbol{U}$, $\boldsymbol{V}$ and a singular value matrix λ;
    (c) estimate a true period p of the source signals from an average of data within rows of the partition matrices $\boldsymbol{X}$; and
    (d) perform an independent component analysis of one of the singular vector matrices $\boldsymbol{U}$, $\boldsymbol{V}$ generated by SVD from the matrix $\boldsymbol{X}$ partitioned in accordance with the estimated period p and so to obtain an independent component matrix $\boldsymbol{UR_2}^T$, $\boldsymbol{R_1}^T\boldsymbol{V}$ and an associated component matrix $\boldsymbol{R_2}\lambda\boldsymbol{V}$, $\boldsymbol{U}\lambda\boldsymbol{R_1}$ characterised in that one component matrix $\boldsymbol{UR_2}^T$, $\boldsymbol{U}\lambda\boldsymbol{R_1}$ contains estimated separated signal modulation envelopes and the other $\boldsymbol{R_2}\lambda\boldsymbol{V}$, $\boldsymbol{R_1}^T\boldsymbol{V}$ contains estimated separated cyclets.

16. A computer-readable medium embodying instructions for execution by a computer processor, the instructions relating to separation of a plurality of source signals from a composite signal (104) expressed as a series of values of signal amplitude, the source

signals having periodicities similar or equal to p, characterised in that the computer-readable medium incorporates program code for controlling a computer processor to:

(a) express the composite signal (104) as a matrix $\boldsymbol{X}$ having rows each of which is a respective segment of signal amplitude values and corresponds to a length of time associated with a signal cyclet;

(b) decompose the matrix $\boldsymbol{X}$ by decorrelation and normalisation to obtain decomposition results; and

(c) perform ICA of the decomposition results to obtain at least one of estimated separated signal modulation envelopes and estimated separated signal cyclets.

17. A computer-readable medium embodying instructions for execution by a processor, the instructions relating to separation of a plurality of source signals from a composite signal (104) expressed as a series of values of signal amplitude, the source signals having periodicities similar or equal to p, characterised in that the computer-readable medium incorporates program code for:

(a) partitioning the composite signal (104) into sections to provide respective rows of a partition matrix $\boldsymbol{X}$;

(b) performing a singular value decomposition of the matrix $\boldsymbol{X}$ to obtain two singular vector matrices $\boldsymbol{U}$, $\boldsymbol{V}$ and a singular value matrix λ; and

(c) performing an independent component analysis of one of the singular vector matrices $\boldsymbol{U}$, $\boldsymbol{V}$ to obtain an independent component matrix $\boldsymbol{UR_2}^T$, $\boldsymbol{R_1}^T\boldsymbol{V}$ and an associated component matrix $\boldsymbol{R_2}\lambda\boldsymbol{V}$, $\boldsymbol{U}\lambda\boldsymbol{R_1}$ characterised in that one matrix $\boldsymbol{UR_2}^T$, $\boldsymbol{U}\lambda\boldsymbol{R_1}$ contains estimated separated signal modulation envelopes and the other matrix $\boldsymbol{R_2}\lambda\boldsymbol{V}$, $\boldsymbol{R_1}^T\boldsymbol{V}$ contains estimated separated cyclets.